CALIFORNIA ENERGY COMMISSION
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STAGE TWO PIER PROGRAM AREAS

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A major accomplishment of the PIER Program's Stage Two Funding is the selection of six Program Areas, together with the formation of a staff team for each area. The team leaders, which in some cases are interim at this time, are listed in the respective program area. The six Program Areas are:

- **Industrial / Agricultural / Water**
- **Residential and Commercial Buildings**
- **Energy-Related Environmental Research**
- **Environmentally-Preferred Advanced Generation**
- **Renewables**
- **Strategic**

Each team has compiled a list of high-level issues, based on input from focus groups, the Policy Advisory Council, and the Commissioners. These draft issues are still a work-in-progress as the teams proceed with the next steps: (1) identification of program goals and objectives; (2) prioritization of technical issues corresponding to the high-level issues; and (3) funding options and strategies.

DRAFT ISSUES FOR RESEARCH IN
INDUSTRIAL / AGRICULTURAL / WATER

Issue 1. On-site power quality and reliability improvements through new technologies can reduce production costs and increase competitiveness of California industry.

Many industries are becoming more sensitive to the quality of the electric power they use. Computer controlled equipment generally cannot tolerate excessive harmonics and VARs. Low-quality power can cause production systems to be unreliable, or can impact their output. New technologies to inexpensively improve on-site power quality, or to improve equipment to tolerate low-quality power can reduce industrial operating costs.

Issue 2. The availability and cost of electricity for water delivery and application or processing affects competitiveness of industry and agriculture as well as raises costs to municipal water and wastewater treatment systems.

The cost of water, its delivery and application for agriculture, industry and domestic uses is high in California where water is a scarce commodity in many areas. Reducing the electricity cost of moving and treating water, purifying and desalinating water, and reducing the amount of water required for process and agricultural production will reduce costs to Californians, and make water-using industry and agriculture more competitive.

Issue 3. Improving process efficiency through improved technologies, management systems with improved sensors and controls, and equipment diagnostic systems reduces energy consumption, thereby improving competitiveness of California industries.

In many industries, new process technologies and better process controls, including early diagnosis of equipment problems, can reduce the energy intensity of the process and reduce "downtime." These new technologies can reduce the cost of production by saving energy, making industry more competitive.

Issue 4. Improvements in electric load management and metering technologies can reduce industrial and agricultural costs to improve business competitiveness.

Combining the load of multiple accounts into one can reduce overall costs of electricity for agricultural and industrial customers. Similarly, improving options to manage load and avoid peak period prices can reduce the cost of electricity for these customers within their applicable tariffs.

Issue 5. Development of technologies to reduce the cost of disposing of industrial wastes and decontaminating water will help the competitiveness of California industry and the state's ability to accommodate growth.

Waste products from agricultural and industrial processes are expensive to dispose. Research is needed to reduce the cost of treatment or disposal through technologies that can help California industries reduce their costs of doing business.

Issue 6. Development of new, innovative technologies, systems or approaches which can reduce the cost of electricity or improve the productivity of electricity used in industrial, agricultural or water-related applications.

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DRAFT ISSUES FOR RESEARCH IN

RESIDENTIAL AND COMMERCIAL BUILDINGS END USE EFFICIENCY

Issue 1. Energy consumption is increasing in hotter, inland areas as new building construction increases in these areas.

Building loads and energy consumption for lighting, air conditioning, and other equipment, particularly during peak periods, can lead to system outages. Research is needed to investigate energy efficiency, load shifting, distributed generation, and real-time energy consumption information options in both new and existing buildings.

Issue 2. Development of energy efficient products and services does not adequately consider non-energy benefits, such as comfort and productivity.

Comfort and productivity are primary drivers in investment in energy efficient products or strategies. Understanding of the benefits and costs of energy efficiency, comfort and productivity is needed for both new and existing building applications to improve the design, adoption, and use of energy efficient products and strategies. .

Issue 3. Building design, construction, and operation of energy features can affect public health and safety.

Building construction, operation of ventilation systems, and certain building materials may contribute to moisture problems and indoor air pollution. Research is needed to construct new buildings and operate existing buildings in a manner that is both energy efficient and healthy.

Issue 4. Investment in energy efficiency affects building and housing affordability and value, and the state's economy.

Research is needed to develop new energy-efficient technologies, including currently undefined innovative advancements which improve housing and commercial building affordability and value through energy efficiency. Additionally, optimization of buildings and equipment to be responsive to California climates and development of improved construction techniques and tools are needed to reduce costs associated with the construction of new buildings and operation of existing buildings.

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DRAFT ISSUES FOR RESEARCH IN
ENVIRONMENTAL

Issue 1: Research is needed to provide solutions which reduce or eliminate the air quality, land use, and water-related impacts of electricity generation, distribution and use in California.

Minimizing the environmental impacts of electricity generation, distribution and use in California, and to more accurately predict and understand the resilience of complex ecosystems to disturbance and crises, is imperative in meeting California's electricity requirements.

Issue 2: Research is needed to understand the nature and significance of global climate change, its relationship to electricity generation and use, and to develop strategies that respond to any identified impacts.

In order to understand the relationship between global climate change and providing electricity to meet California's energy needs, research should first focus on California's contribution to global climate change. Based on the results of this initial research, strategies and solutions tailored to California's energy sector can be developed.

Issue 3: Research opportunities should allow for the innovation of the market to develop solutions to environmental issues.

Important environmental research opportunities may present themselves during the course of the PIER program. A place holder should be reserved to allow for research opportunities which develop solutions in response to these opportunities.

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DRAFT ISSUES FOR RESEARCH IN
ENVIRONMENTALLY-PREFERRED ADVANCED GENERATION

The relatively high cost of electricity for California citizens and businesses imposes a financial burden and impairs California's ability to compete effectively. A component of that cost is electricity. New environmentally-preferred technologies and strategies are needed to produce and deliver electricity at lower cost and decreased environmental impacts.

Issue 1. Reducing the cost of electricity through significant advances in generation efficiency are limited by the technologies currently used in commercially available generation systems.

Most present development efforts result in only small improvements in generation efficiency. Innovative approaches to RD&D in science, technologies, and systems are needed to achieve improvements in efficiency which are not adequately funded by the commercial sector because of the high risk. Funding is needed to encourage manufacturers to participate in the development of environmentally-preferred advanced cycles, new technologies, and synergistic hybrid systems and applications.

Issue 2. System reliability and the cost of electricity are adversely affected by California's large inventory of outdated steam power plants.

Aging central station power plants with existing infrastructure cannot operate economically in a deregulated electricity market. In addition to raising the cost of electricity, the operating limitations of these plants may also contribute to decreased system reliability and overall higher emissions. Must-run generation status in transmission constrained areas of the State (and elsewhere) results in very poor thermal efficiency and high risk of system failure should one or more plants fail unexpectedly. Research is needed to develop and demonstrate alternate replacement environmentally-preferred technologies capable of superior performance, thus allowing the older plants to be retrofitted, replaced or retired.

Issue 3. New cost-effective pollution control technologies are needed to reduce the health and environmental impacts from power plant emissions.

As environmental and health concerns grow, current emission controls for generation technologies are not likely to satisfy anticipated Federal, State, and local air pollution limits in the future. In addition to needing improved mitigation without the use of hazardous materials, reduced capital and operating costs are needed to assure market acceptance. RD&D is needed to find cost-effective and benign means of emissions control for all generation combustion systems, especially for high efficiency natural gas-fired plants.

Issue 4. Small and intermediate scale environmentally-preferred power generation technologies and systems are needed that can be efficiently and cost-effectively used as distributed generation resources.

In a restructured market, distributed generation has the potential to reduce the cost of electricity, improve local power quality, increase system reliability, and postpone or eliminate the need for new or expanded transmission and distribution facilities, and improve the environment. Environmentally-preferred advanced generation technologies needed to facilitate distributed generation are not ready for the marketplace. RD&D is needed to encourage and accelerate development and application of these technologies.

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DRAFT ISSUES FOR RESEARCH IN
RENEWABLES

Issue 1. Renewable energy systems should develop reliability and dispatchability that enhance their value as an energy resource.

With some exceptions, such as hydroelectric systems, renewable electricity generation systems lack the same degree of reliability and dispatchability as existing fossil fueled generation systems. This lack of high reliability and dispatchability prevents renewables from being competitive in California's deregulated electricity marketplace. RD&D efforts should focus on improving reliability and dispatchability of renewable systems (e.g., perhaps through development of lower cost storage capabilities) that will enhance the value and competitiveness of renewables as an energy resource in a deregulated electricity marketplace.

Issue 2. Improvements in power quality, dispatchability and safety control features will help alleviate concerns associated with the tie-in of a number of distributed renewable energy systems into California's grid system.

R*enewable energy technologies are good candidates for distributed energy generation, and yet, there are concerns regarding possible impacts of renewable systems on the safety and power quality within distribution lines. In addition, the inability to dispatch them on command has limited their acceptance as distributed generation resources. RD&D efforts should be directed to developing improved control over power quality and dispatchability of distributed renewable energy systems, and safety features that isolate or prevent downstream electrical safety problems.*

Issue 3. It is important to reduce the cost of renewable energy systems to improve their value as part of the overall electricity system and sustainability.

Although renewable energy technologies have a wide variety of capital and operating costs, most renewables are not currently cost competitive in a deregulated electricity market. To be market competitive, research and development is needed to lower capital costs, improve conversion efficiency and reduce O&M costs. In addition, R&D efforts should take into account opportunities for renewables to be competitive in niche markets as a way of eventually working their way into a position of broad market competitiveness.

Issue 4. Renewable generators in California may be under-utilizing wastes as an energy resource.

To date, only clean agricultural and forest residues have been used to any extent for electricity generation in California. Most residues and wastes are viewed as a disposal problem rather than fuels for renewable energy generation. There is limited information on the use, environmental impacts and economics of wastes as feedstocks for energy generation and for production of value-added products. In addition, only limited work has been done to examine the potential to improve combustion and power production using co-firing techniques. RD&D efforts should focus on ways to use waste as a renewable energy feedstock in an environmentally beneficial manner, and develop

co-firing techniques that will help resolve waste disposal issues while simultaneously shifting some of the costs away from electrical customers.

Issue 5. Renewable energy systems will benefit by improving their integration into existing environments or structures, and by being rewarded economically for providing non-energy benefits in addition to their energy value.

The unobtrusive integration of an energy technology into a consumer's existing environment is important to its marketability. In addition, marketability is enhanced if the technology provides value in addition to its energy related benefits. Most renewable energy technologies stand out from their existing environment, leaving a noticeable footprint or difference in appearance. Few renewable energy technologies are rewarded economically for providing non-energy benefits to the marketplace. Some technologies, like roof top integrated photovoltaic systems, fit more seamlessly into the existing structure, providing non-energy benefits by both acting as the rooftop and prolonging the life of the rooftop substructure. R&D efforts should focus on developing renewable energy technologies that integrate better with existing structures, enhancing those features that result in economic rewards for both energy and non-energy benefits.

Issue 6. Renewable energy advancements may occur in areas unexpected by the current R&D community, or market conditions may change in such a manner as to drive R&D into new areas. This R&D program should allow for such innovative projects.

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DRAFT ISSUES FOR RESEARCH IN
STRATEGIC AREAS

Under the restructured electricity market, critical infrastructure changes are necessary to allow transactions to be made in an efficient, effective, reliable and environmentally acceptable manner. The electricity infrastructure includes generation, transmission, distribution, end-use control technologies, and communications, all functioning in an integrated, cohesive fashion. The existing infrastructure does not have the technologies available to facilitate a market likely to be characterized by many more participants making and implementing many more decisions about electricity production, distribution, and use. There are strategic needs for 1) enabling technologies to maintain infrastructure stability and responsiveness, 2) technology capability of providing all customer classes with meaningful access to the benefits of restructuring while minimizing transaction costs, and 3) techniques and technologies which can more appropriately respond to volatility in prices.

Further, electricity is likely to become more substitutable with other energy forms and inputs of production (the phenomenon of "convergence") as a short run marginal alternative (i.e. operational choice) in addition to long run alternative (i.e. capital investment choice.)

Issue 1: Technologies need to be developed to facilitate the expanded use of distributed energy resources, including interconnection, inverters and other systems controls, as well as predictive models. The impact of a wide-scale grid-connected distributed energy resources on the dispatchability of resources and the integrity of distribution and transmission systems needs to be determined.

Issue 2: Improved communications protocols are needed to reduce transaction costs for small customers, including demand bidding and load management. Information alone, however, may not be enough if a customer is unable to discern what the information means and how it could be used. Advanced metering technologies are needed to facilitate seamless, two way real time pricing information and responsive demand-side behavior. This needs to be coupled with common architecture and communication protocols to allow modularization of metering for customer specific applications. There is also the need to guarantee privacy, integrity, security, speed, and appropriate accessibility of data.

Issue 3: The economics and other characteristics of electricity storage technologies need to be improved as an alternative to generation and/or transmission, system control, and load management, and power quality capabilities to customers, particularly industrial and commercial. Storage technologies may address power quality related problems which can have significant economic and reliability impacts.

Issue 4: Technologies need to be developed to make the electricity system more robust in the event of natural disasters (e.g., earthquakes); to suffer less damage and/or to reduce restoration time.

Issue 5: Advanced technologies are needed to improve the reliability, operability and efficiency of the transmission, distribution and delivery grid, in conjunction with research undertaken by the regulated market.

Issue 6: There is a need to maintain long term, cross cutting and innovative advancements of science and technologies whose future applications may be unclear today. Cross cutting research should address and balance opportunity and benefits in multiple program areas. Development of energy-related technologies that enable multiple applications of strategic importance is especially critical.

Issue 7: There is a public interest need to develop advanced mathematical models to better analyze and undertake research on the market structure within which electricity transactions occur, performance of the market and associated signals for technological innovation, and how electricity related technologies function within the market.

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